Walking toward moving goalposts: agile management for evolving systems

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Main points

- ~~Bolt-on management considered harmful~~
- Proponents of building self-management into system
  - Bolt-on = management separate from and external to system under management

- An architecture pattern for building distributed systems: layering and federation

- Investigating simplest possible specifications

Research direction

- Self-management without a central management authority
  - In a storage system as an example
- Can we make a system administratorless?

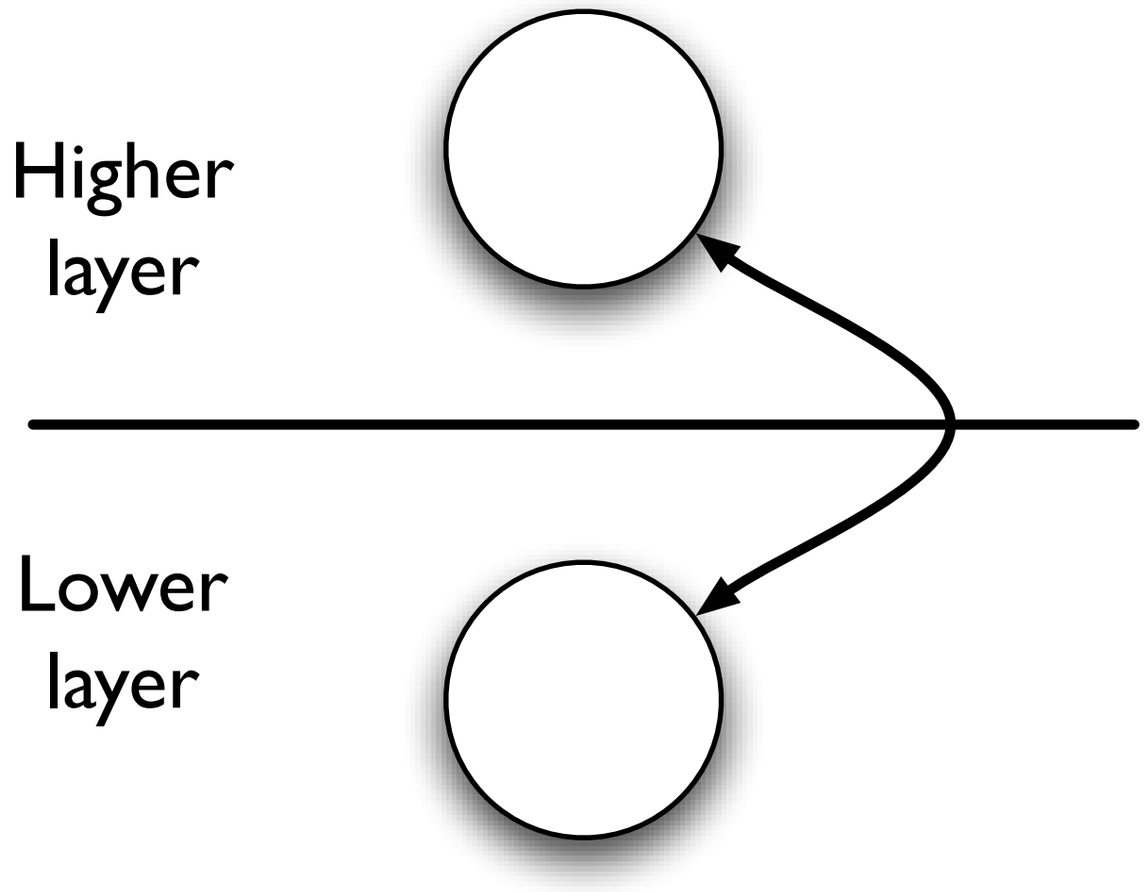
- Almost all storage systems use centralized management
  - Metadata server
  - Exception is peer-to-peer... but most of those are limited in function (e.g. read-only)

Why is this decentralization worth while?

- Some environments require it
  - Cooperating organizations—no single business authority
  - On-demand provisioning from competing service bureaux
- Possible route to aligning vendor economic incentives
  - Systems *do* get smarter over time
  - Currently: system vendors have incentive for incompatible differentiation
  - Can a higher-level standardized interface help?

Architecture: layering

- For any given problem:
  - Delegate to lower level?
  - Use global view of higher level?

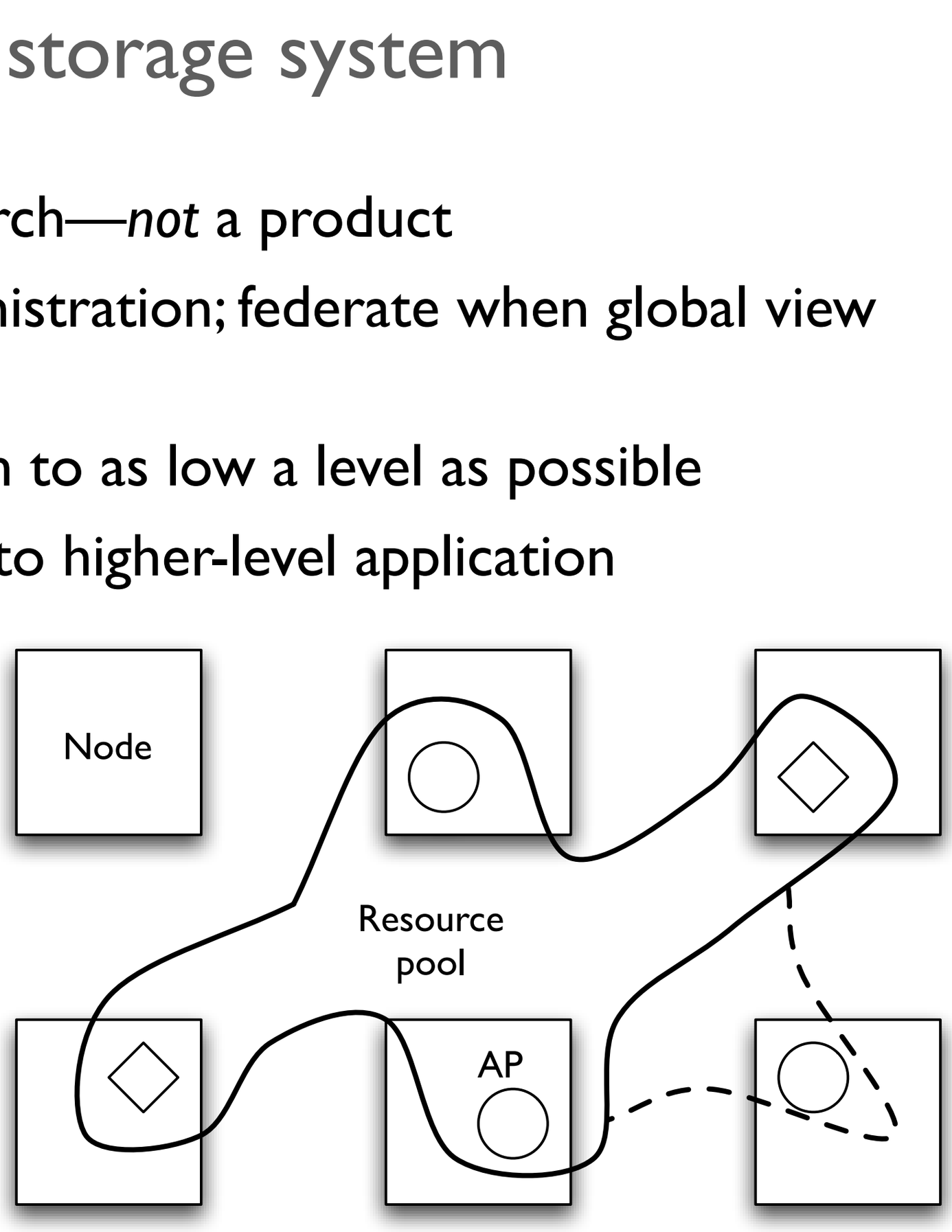


Simplest possible specification

- Desire for human understandability
- How well will it go if we start from minimum possible?
  - Existing storage management started from high-fidelity
    - Is directionally accurate sufficient? 90% solution? Iterative tuning?
- Can we mask local complexity?
  - Makes global decision algorithms easier
  - Smart local resource management

K2 distributed storage system

- Vehicle for research—*not* a product
- No central administration; federate when global view needed
- Delegate function to as low a level as possible
- Provide support to higher-level application management

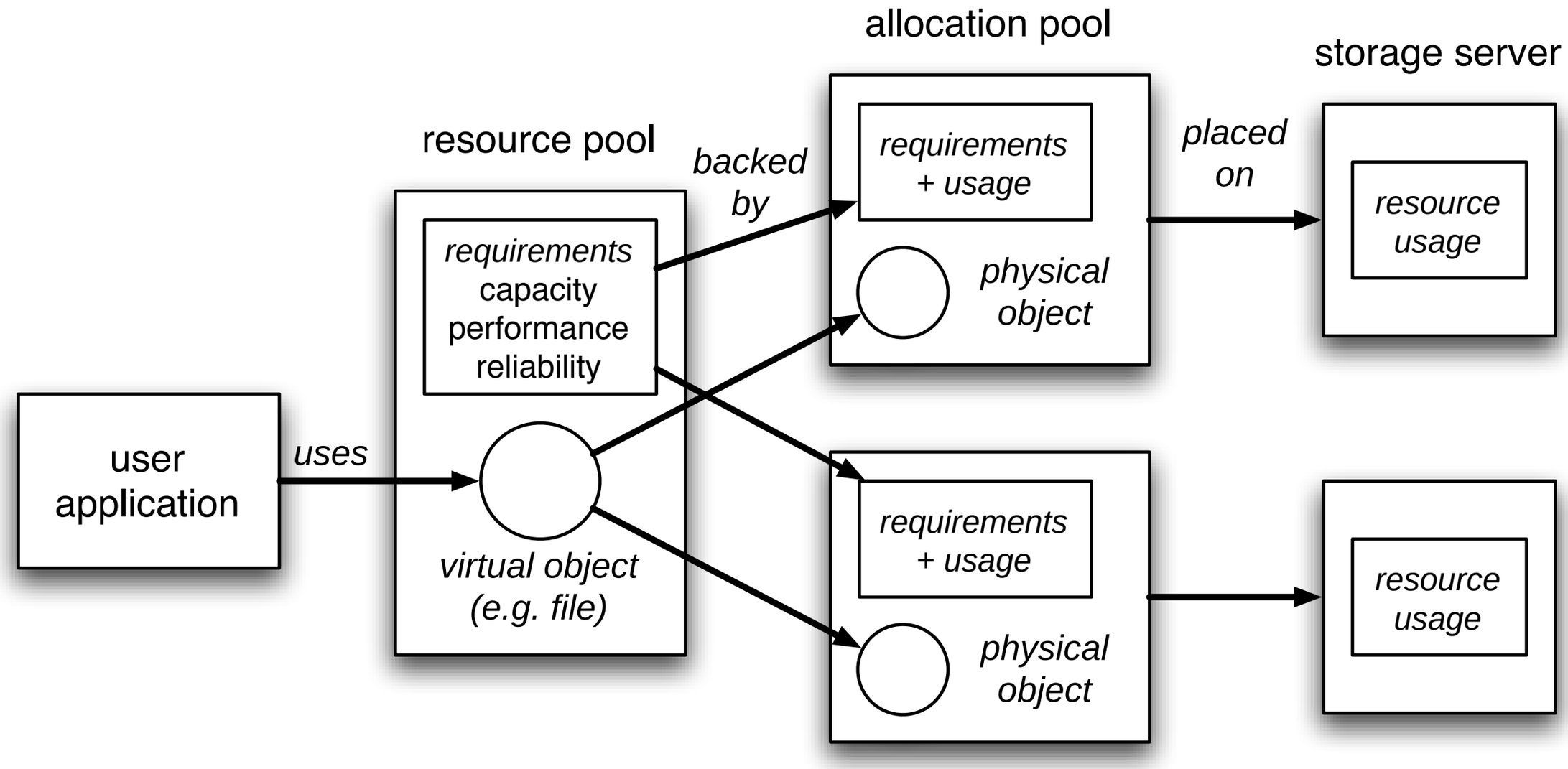


Resource pools: external view

- A virtual collection of storage
- One per user or application
- Each pool is independent
- Specified by:
  - Capacity, Performance, Reliability
  - Reserve and limit

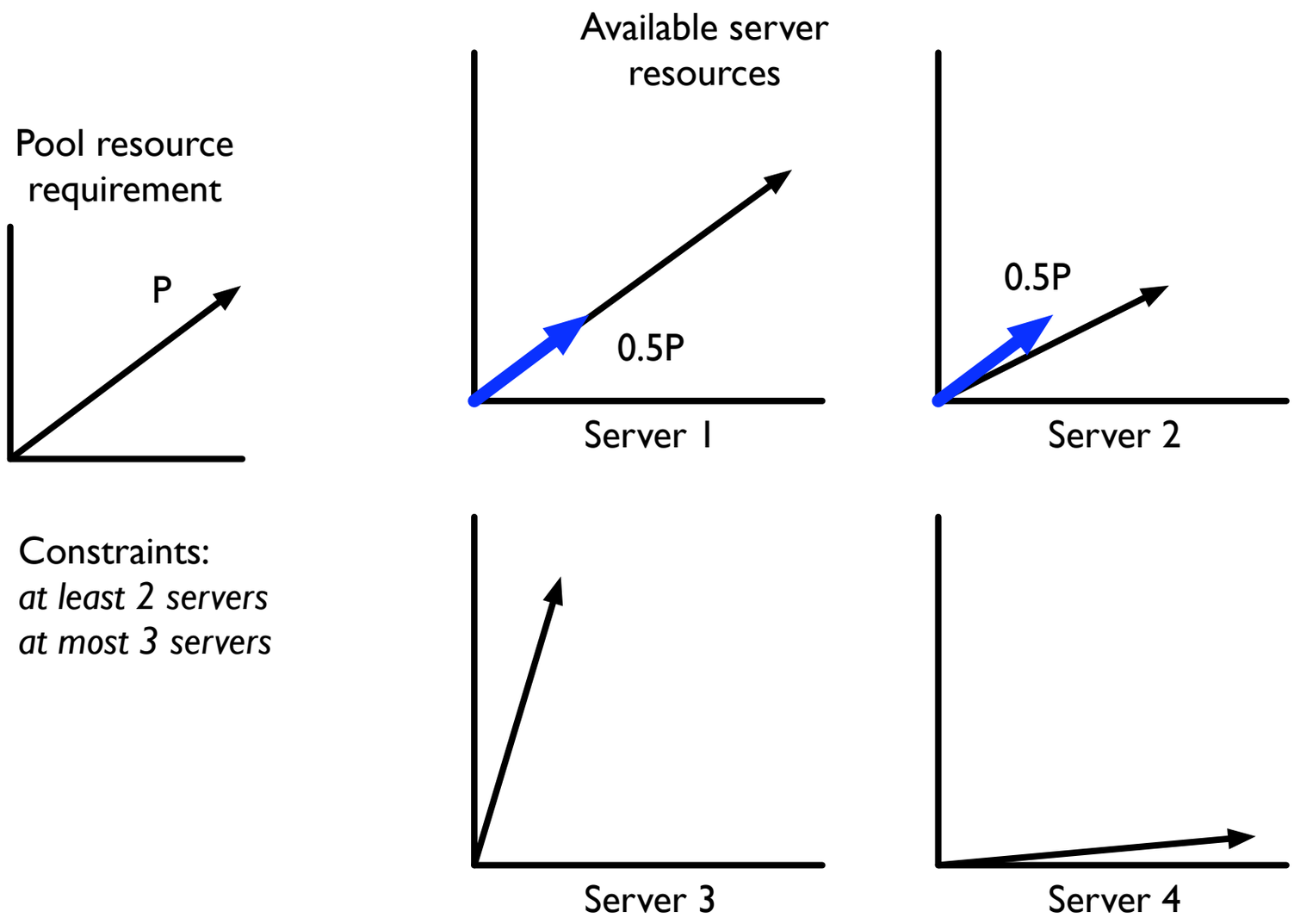
- Initially: capacity = bytes; performance = IO/s; reliability = MTTDL

Implementing pools



- Virtual pool backed by physical allocation pools
- Pools contain objects for storing user data
- Decision algorithm: how much to put where
- Storage server enforces resource allocation

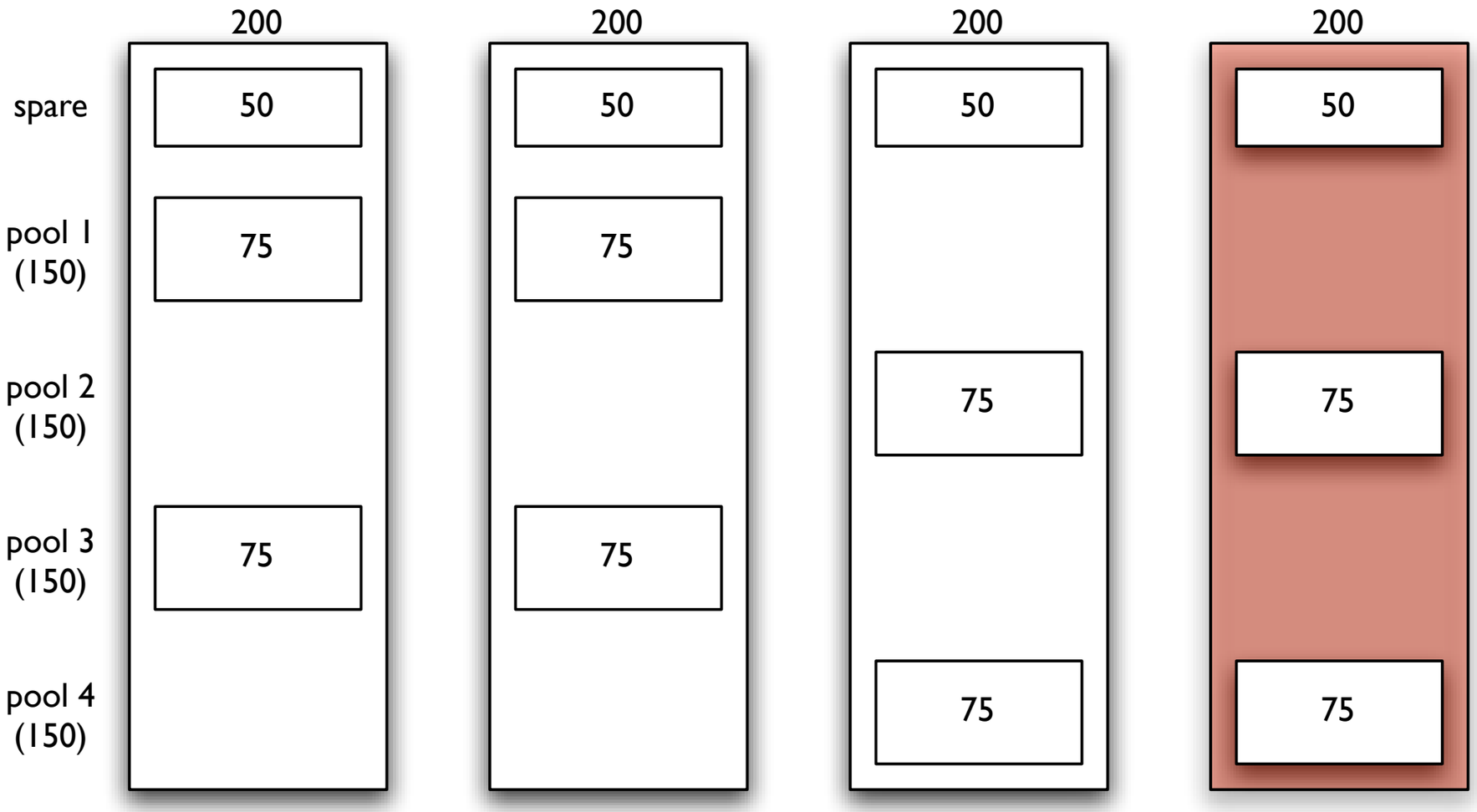
Resource allocation decisions: normal



- Normal case: online decision for one pool
  - Creating or modifying a pool's requirements
  - Load balancing
- Use constrained multidimensional bin packing
- Constraints derived from reliability requirements

Resource allocation decisions: failure

- Multi-pool assignment required
- Backtracking search for feasible solution (better is possible)



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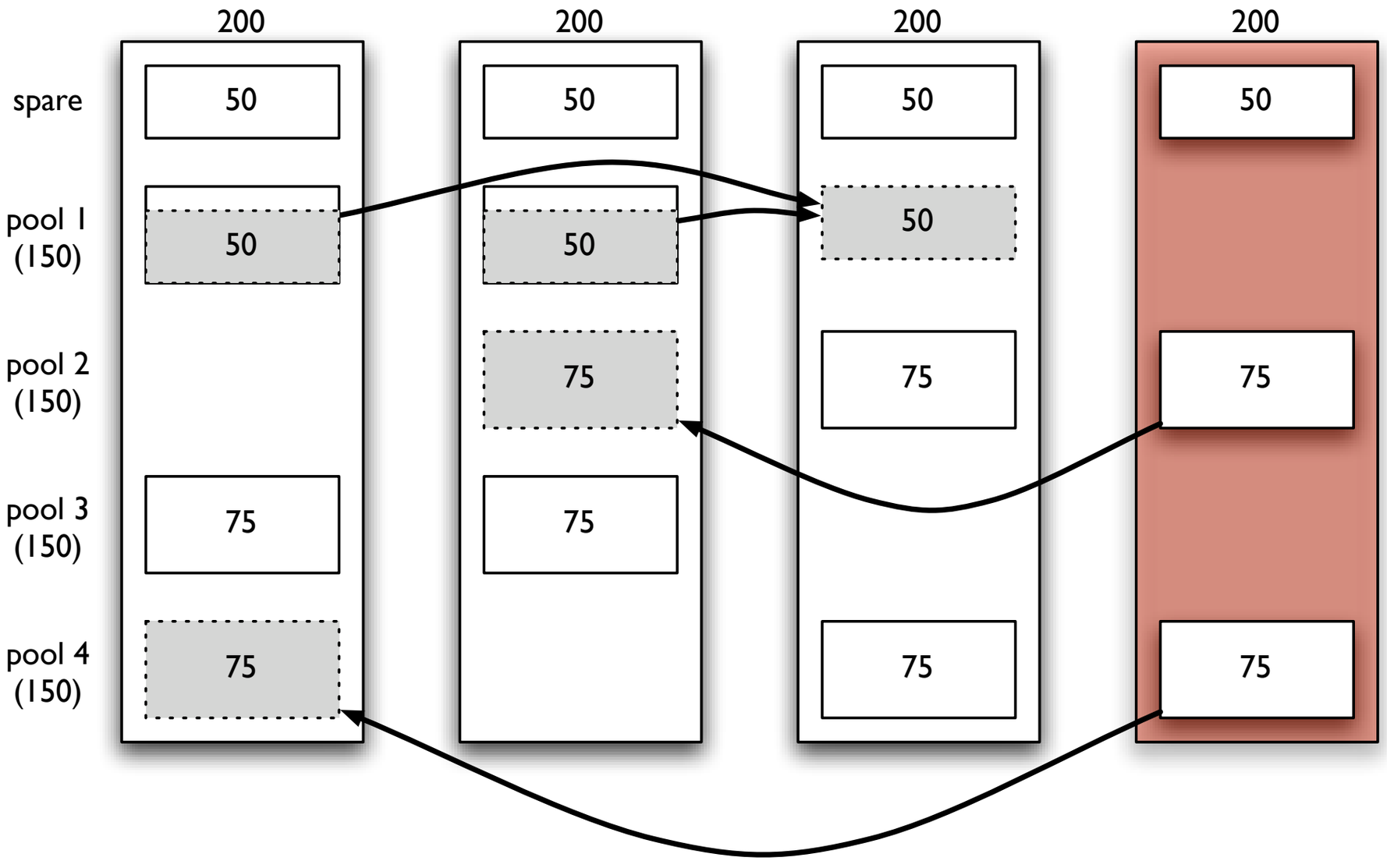
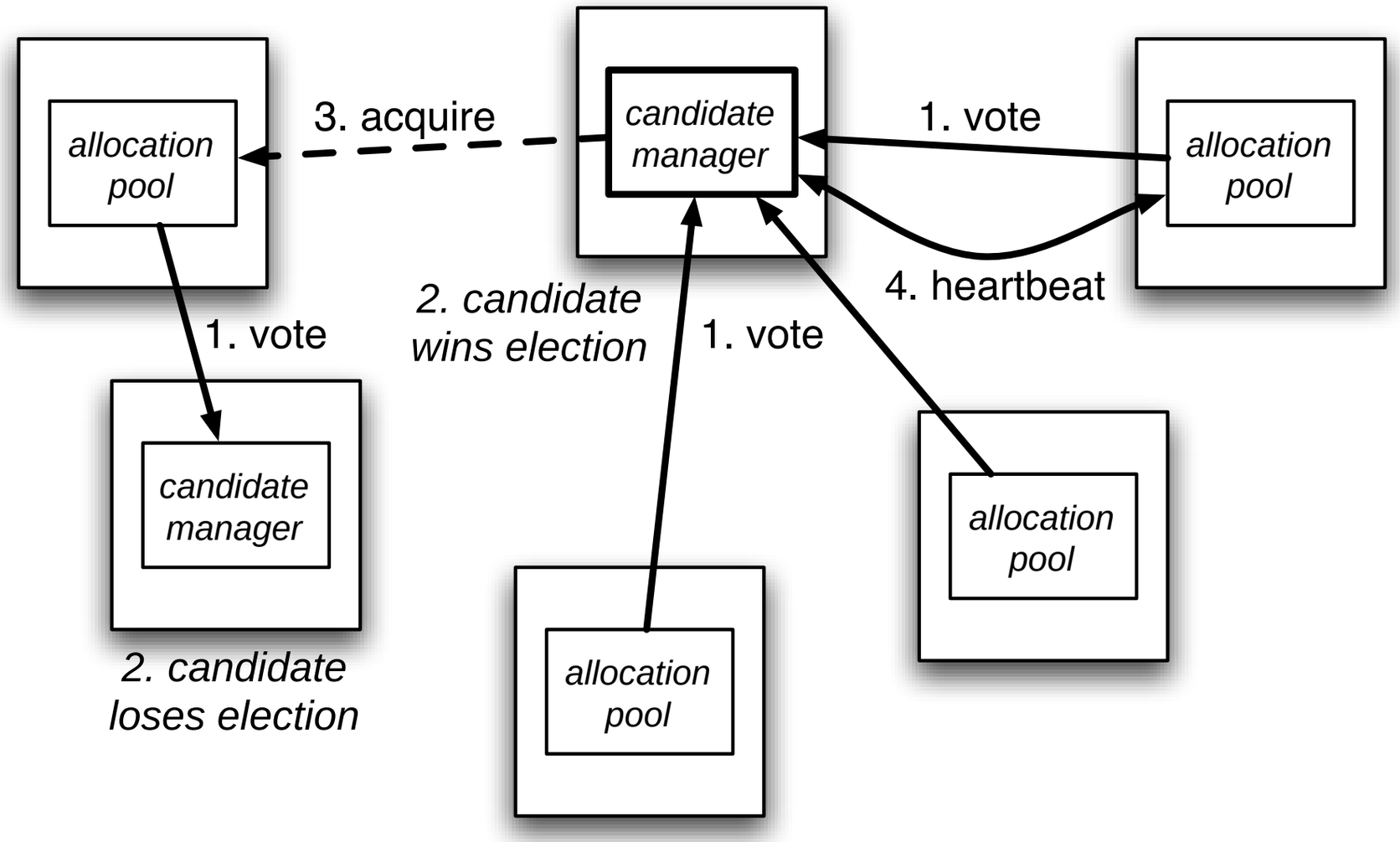


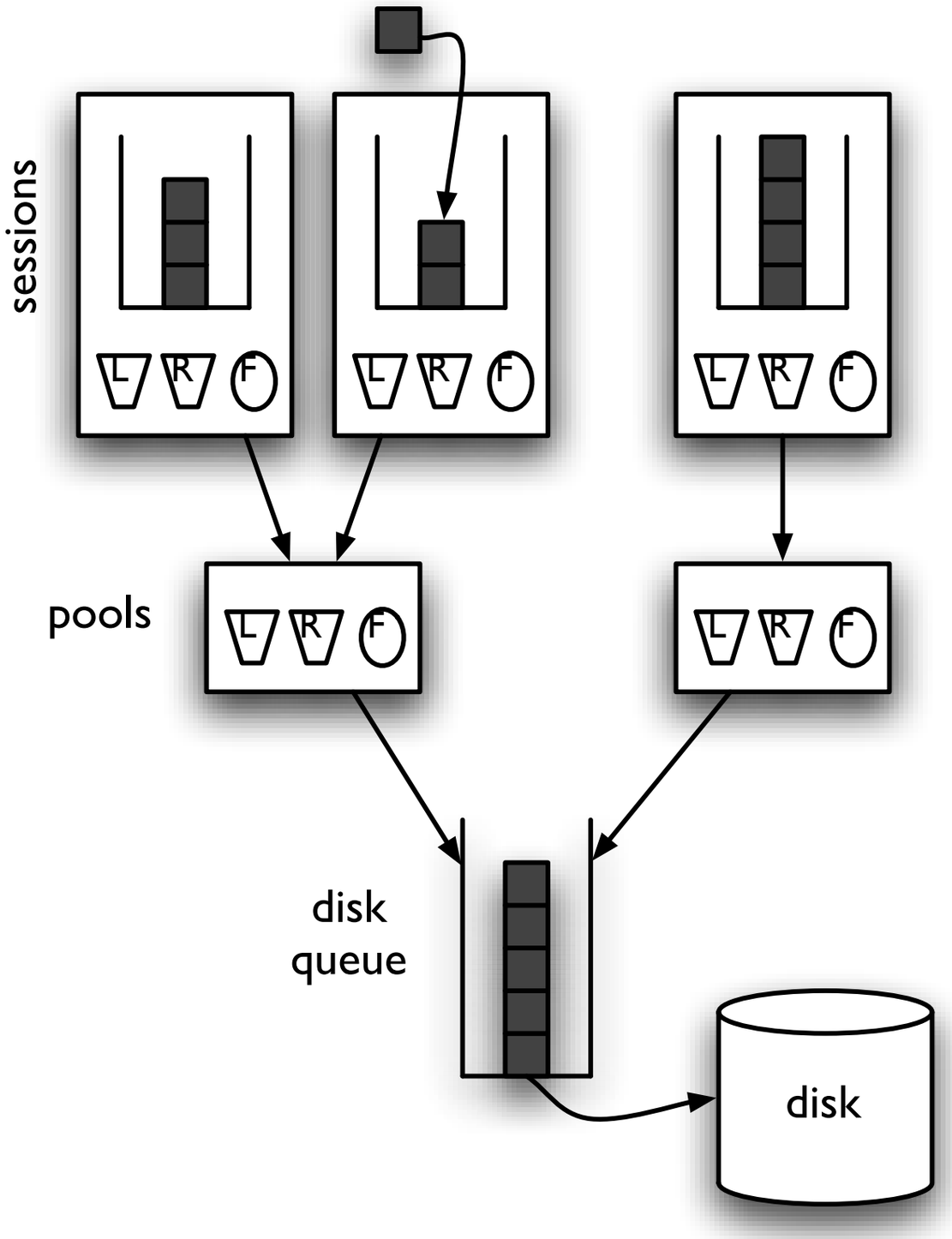
Making decisions



- Each resource pool is an independent group
- APs elect a manager; manager watches over pool
- Manager is disposable
- Manager runs decision algorithm
- All information in allocation pools

Local resource management

- Goal: isolation between pools
- Capacity: just accounting
- Performance: requires scheduler
- Tradeoff: performance vs. efficiency
- Provides reserve and limit, plus fair sharing
- Working to add cache, network



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